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i-Tree

Introduction

Throughout the twentieth century, the global urban human population has significantly increased and now, for the first time in recorded history, over half of the world's population live in towns or cities. This proportion is predicted to increase further, reaching 70% by 2050, and urban areas continue to expand at a faster rate than any other land-use type. At the same time, land use policies are recognizing the need to preserve and enhance ecosystem goods and services. Yet, despite the importance of urbanization as a major driver of land-use across the world, there have been surprisingly few attempts to quantify the benefits of ecosystem services at a city-wide scale. This may be due to a belief that urban ecosystems have limited ecological value because they are altered by humans. Our study quantifies a sub-set of ecosystem services in an urban environment ecosystems. Generally we ask: What are the services that the trees located on the University of Mary Washington (UMW) campus provide for the faculty and student population? Specifically, what amount of carbon is removed from the atmosphere by each species of tree through sequestration and storage?

Methods

We used the USDA's i-Tree Eco software to estimate carbon sequestration and storage using data collected from landscaped trees on the UMW Fredericksburg Campus. i-Tree Eco uses tree species, tree size and modeled tree physiology to calculate tree-environment interactions. For instance, i-Tree Eco models carbon uptake and storage of CO^2 by individual trees. This carbon uptake is a service to humans as a potential mitigating factor in climate change.
Our first step was to measure each tree. Tree size measurements taken were:

- Diameter Breast Height (DBH)
- Total Height
- Canopy Width, in N/S and E/W directions.

Next, all data was extracted from an ArcGIS database into an inventory list created using Microsoft Excel. This list consisted of:

- Common Names
- Botanical Names
- DBH (cm)
- Total Height (m)
- Canopy Width (m)
- Land Use (Residential)

Any tree with incomplete or missing data was removed from the inventory sheet submitted to i-Tree Eco. i-Tree Eco requires complete data to provide the requested information on carbon sequestration and storage. This reduced the amount of tree data provided from 1837 to 945.

The completed inventory sheet was then transferred from Excel to i-Tree Eco. The data that was used was:

- Common Name
- DBH (cm) (up to 3 DBH measurements per for multi-stem trees)
- Total Height (m)
- Land Use (Residential)

Once our data was submitted to i-Tree Eco, we received a report, per tree species, regarding sequestration and storage, that is being removed from the atmosphere as seen in Figures 2-4.

Results

Total Average				
Common Name	**DBH**	**Canopy N/S**	**Canopy E/W**	**Total Height**
American Beech	53.6	13.6	12.9	21.6
American Holly	32.0	6.5	6.4	11.5
Eastern Red Cedar	41.1	7.8	7.2	13.3
Japanese Zelkova	47.5	12.5	11.5	12.9
Pecan	75.6	20.8	20.0	26.6
Red Maple	41.5	10.3	10.6	15.6
Sugar Maple	33.6	10.7	11.6	22.7
White Ash	67.3	14.0	16.9	22.0
White Oak	66.4	12.5	13.1	19.1
Willow Oak	93.9	20.3	19.1	23.3

Figure 1: Total Average measurements of the top 10 species of tree reported by i-Tree Eco for sequestration and storage.

Results Continued

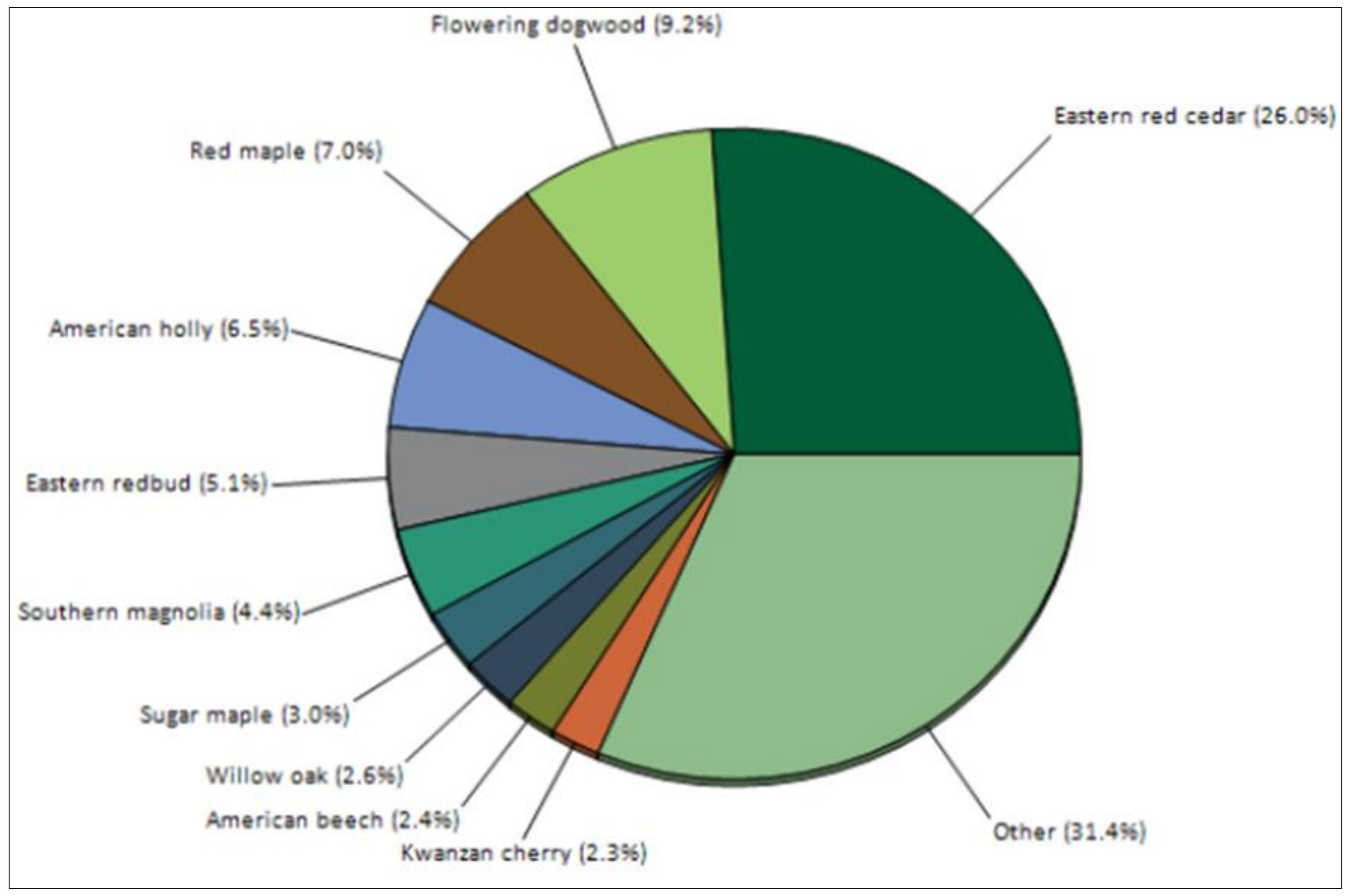

Figure 2: Tree species composition of landscaped trees on the University of Mary Washington campus.

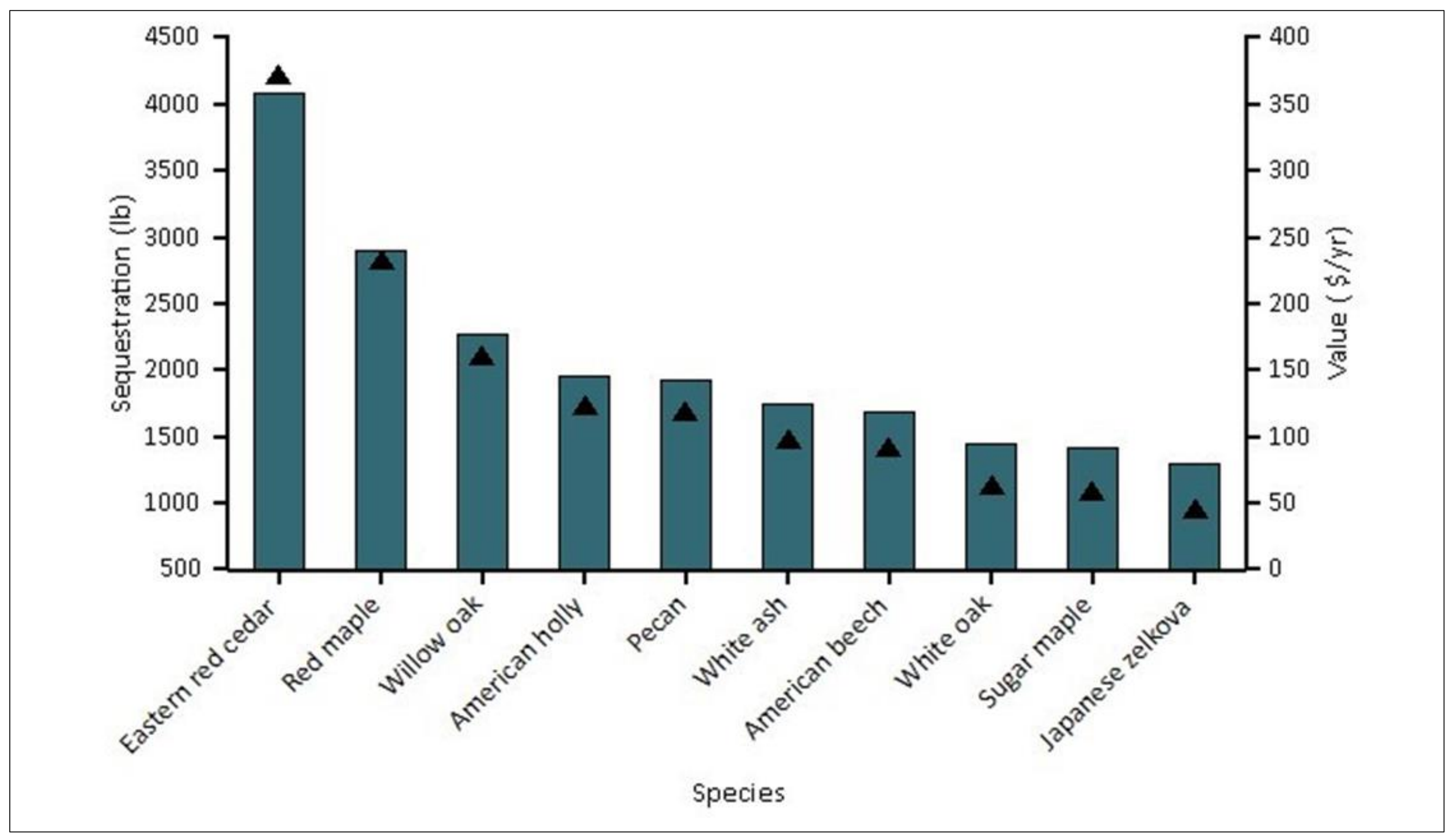

Figure 3: Estimated annual gross carbon sequestration (triangles) and value (bars) for urban tree species with the greatest sequestration.

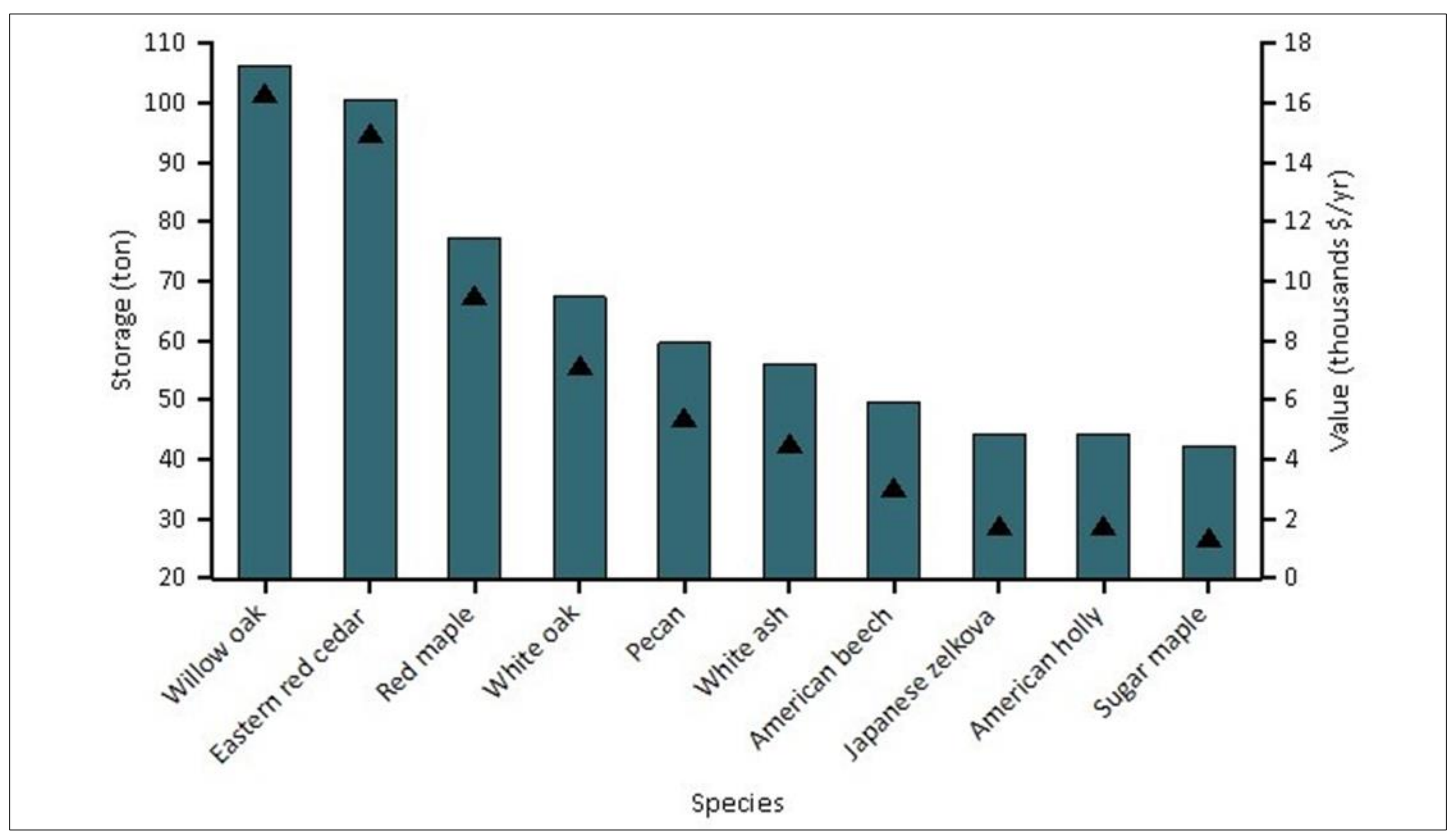

Figure 4: Estimated carbon storage (points) and values (bars) for urban tree species with the greatest storage.

Discussion

As can be seen by that data, there is a huge difference in which species of tree has a higher estimated annual gross carbon sequestration (Eastern red cedar) and which species has a higher estimated carbon storage (Willow oak).

Trees reduce the amount of carbon in the atmosphere by sequestering it in new growth every year. The amount of carbon annually sequestered is increased with the size and health of each individual tree. This is can also be said about the amount of carbon a tree can store. As a tree grows, it stores more carbon by holding it in its accumulated tissue. As a tree dies and decays, it releases much of the stored carbon back into the atmosphere, thus carbon storage is an indication of the amount of carbon that can be released if trees are allowed to die and decompose.

Though Eastern red cedars and Red maples conduct majority of the sequestration out of all the trees located on the UMW campus, it seems to be this is because there are a higher percentage of these trees across the university campus compared to the others listed. Willow oaks, which store the largest amount of carbon, are larger is size when comparing the total averages of each measurement. This species of tree is also third when it comes to carbon sequestration even though it only comprises 2.6% of all trees planted across the UMW campus. Willow oaks prove that the relative size and growth rate of a tree determines how much carbon can be sequestered and stored throughout its entire lifespan.

Conclusions and Future Work

In conclusion, having a larger number of trees may produce a higher percentage of sequestration but does not mean that those same trees will store more carbon as seen between the Eastern red cedars that make up 26% (246) of the tree population within the data submitted and Willow oaks that make up only 2.6% (25). The larger Willow oaks store more carbon and sequester almost half of the amount Eastern red cedars sequester even though their numbers are 10x less.

When it comes to the maintenance and planting of these trees, it would be more advantageous and cost efficient to plant more Willow oaks in place of the Eastern red cedars. Even the amount at Willow oaks would be far less in number to maintain and care for to produce similar results to that of Eastern red cedars.

At the same time we were unable to insert all measurements collected due to lack of data needed for i-Tree Eco to consider the size of each trees canopy. . i-Tree Eco refers to this data as Crown size, crown meaning canopy, and requires the; height to live top, height to crown base and crown width before the data can be processed. Since the data was not collected on the height to live top and crown base, we were unable to input the measurements causing the results to be more generalized on each tree species.

Future work needs to be done measuring the Crown size of every landscaped tree planted across the UMW campus as well as recording the Crown health and Crown light exposure. This will give us a more specific visual picture of what these trees are doing for the university not just with carbon removal but with other economic factors such as energy/money saved from heating/cooling.

References and Acknowledgements

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